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141940

SCANNING SYSTEM, INFRARED
NOISE EQUIVALENT TEMPERATURE DIFFERENCE
MEASUREMENT PROCEDURE

Job Order 46-315

(NASA-CR-141940) SCANNING SYSTEM, INFRARED
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Prepared By

Lockheed Electronics Company, Inc.
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For

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TECHNICAL REPORT INDEX/ABSTRACT


(See instructions on reverse side.)

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NOISE EQUIVALENT TEMPERATURE DIFFERENCE
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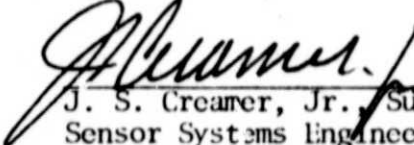
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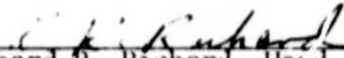

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1.0 GENERAL

This document presents procedures for the measurements of the noise equivalent temperature (NEAT) of infrared scanning systems operating in the thermal region of the spectrum.

This document applies to the following instruments:

- a. RS-18, Texas Instruments
- b. Reconofax IV, HRB Singer
- c. M²S, Bendix.

2.0 DEFINITIONS

The noise equivalent temperature difference (NEAT) of an infrared scanning system is defined as the temperature difference, in degrees Centigrade ($^{\circ}\text{C}$), between two adjacent targets which will produce a peak-to-peak electrical signal equal to the rms noise in said signal. Unless otherwise specified, these targets are close to ambient temperature. However, in order to enhance measurement accuracy, one target may be as much as 10°C above ambient. Also, unless otherwise specified, each target is large in relation to the size of the scanner aperture.

3.0 REFERENCE DOCUMENTS

The following documents will be referenced for additional information.

- a. RS-18 Operation and Maintenance Manual, Texas Instruments, Inc., 1974 (Contract NAS 9-13388).
- b. Reconofax IV Operation and Maintenance Manual, HRB Singer, Inc., 1966.
- c. M²S Operation and Maintenance Manual, Bendix Aerospace Systems Division, April 1974.

4.0 EQUIPMENT REQUIRED

This section presents the equipment required to perform an accurate NEAT measurement. The equipment includes the following:

- a. Scanner under test
- b. Oscilloscope
- c. True -- rms voltmeter
- d. Two water trays, both of which are at least twice the size of the system aperture at a distance of one foot or more from the aperture
- e. Two laboratory thermometers calibrated in °C.

5.0 REQUIREMENTS

5.1 Handling Requirements

The RS-18, Reconofax IV, and M²S are delicate, high-precision electro-optical instruments. The following special requirements should be observed:

- a. Prevent the instruments from receiving mechanical shock. In addition to obvious structural problems which could occur, the precision optical alignment of these instruments could be disturbed.
- b. Use caution to keep contaminants away from the optical surface of these instruments. In no case should the optical surfaces be touched with the bare hand.
- c. Observe all special precautionary measures outlined in the respective operations manuals (section 3.0).

5.2 Power Requirements

Each of the scanners covered by this procedure require different power input voltage. Care should be taken to provide power as outlined in the operating procedure (see section 3.0) which is free of extraneous noise which may effect proper operation. Care should also be used to avoid ground loops which may contribute to excessive noise on output signals.

6.0 NEAT PROCEDURE

Follow this procedure to obtain data for calculating NEAT in the laboratory. Required equipment is listed in section 4.0.

1. Set up the scanner on an appropriate stand such that the pans of water can be placed in the field-of-view of the scanner optics without obstruction. Connect the proper cabling and power to the scanner under test.
2. Connect both oscilloscope and true-rms voltmeter to the preamplifier output of the system under test. Refer to the appropriate manual listed in section 3.0 to determine where to make this connection.
3. Connect power to the system and operate per Operation Manual to verify that the system is operational.
4. Noise measurement - With the scanner energized and the scan mirror not rotating, or with the scan mirror rotating and the detector covered, measure the noise voltage at the preamplifier output with a Ballentine, or equivalent, true-rms meter.
5. Delta signal measurement - With two (2) pans of water of known temperature in the live-video field-of-view and the scanner mirror running, measure the peak-to-peak signal voltage difference in the signals with an oscilloscope. Record the voltage difference. The difference temperature of the water should be at least 2°C to 5°C differential. The voltage difference in the signals from the two (2) pans of water will be defined to be the

Delta signal. The water should be agitated sufficiently to eliminate thermal gradients. Carefully read the two thermometers, without removing the bulbs from the water. Record these readings.

7.0 NEAT CALCULATION

System NEAT (Noise Equivalent Delta Temperature) will be calculated from the following formula:

$$NEAT = \frac{(T_2 - T_1) \cdot V_n(rms)}{\Delta V_s}$$

where NEAT is in degrees Kelvin,

T_2 and T_1 are temperatures of the pans of water in °C,

$V_n(rms)$ is the rms noise voltage and,

ΔV_s is the Delta signal from the oscilloscope reading.